

## CLEAN VERSION OF AMENDMENTS

### In the claims:

The following is a complete listing of a clean version of the presently pending claims; claims amended hereby are so indicated by the parenthetical expressions "amended":

Sub D1  
C1  
~~44. (amended) An apparatus for interfacing a user with a computer providing a laparoscopic surgical simulation, the apparatus comprising:  
a user object simulating at least a portion of a medical instrument used in a laparoscopic surgical procedure, said user object comprising a handle and an elongated member;  
a gimbal mechanism receiving the user object and allowing the user object to be manipulated in first, second and third rotary degrees of freedom and in a first translational degree of freedom, the gimbal mechanism comprising a closed loop five member linkage to provide the first and second rotary degrees of freedom; and  
a sensing system coupled to the gimbal mechanism to detect manipulation of the user object in the first, second, and third rotational degrees of freedom and in the first translational degree of freedom, wherein said sensing system provides sensor input related to said manipulation in said first, second, and third rotational degrees of freedom and said first translation degree of freedom to said computer to control a virtual reality image in said laparoscopic surgical simulation displayed on a display device by said computer.~~

45. An apparatus according to claim 44 further comprising a handle sensor coupled to the handle to detect manipulation of at least a portion of the handle.

46. An apparatus according to claim 44 wherein the handle comprises relatively pivotable portions.

47. An apparatus according to claim 46 further comprising a sensor coupled to the handle to detect relative motion of the pivotable portions.

48. An apparatus according to claim 44 wherein the handle comprises a finger wheel. C

49. An apparatus according to claim 44 further comprising a barrier between the handle and the gimbal mechanism.

50. An apparatus according to claim 44 further comprising a trocar between the handle and the gimbal mechanism.

Sub  
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8 51. (amended) An apparatus for interfacing a user with a computer providing a laparoscopic surgical simulation, the apparatus comprising:

a user object simulating at least a portion of a medical instrument used in a laparoscopic surgical procedure, said user object comprising a handle and an elongated member;

C2 a gimbal mechanism receiving the user object and allowing the user object to be manipulated in first, second and third rotary degrees of freedom and in a first translational degree of freedom, the gimbal mechanism comprising a closed-loop five member linkage to provide the first and second rotary degrees of freedom;

a sensing system coupled to the gimbal mechanism to detect manipulation of the user object in the first, second, and third rotational degrees of freedom and in the first translational degree of freedom, wherein said sensing system provides sensor input related to said manipulation in said first, second, and third rotational degrees of freedom and said first translation degree of freedom to said computer to control a virtual reality image in said laparoscopic surgical simulation displayed on a display device by said computer; and

an actuator coupled to the gimbal mechanism to output a force to the user in one or more of the degrees of freedom, wherein the actuator outputs one or more forces associated with the simulation.

52. An apparatus according to claim 51 wherein the actuator comprises a motor.

53. An apparatus according to claim 51 wherein the actuator comprises a braking mechanism.

54. An apparatus according to claim 51 further comprising additional actuators so that forces may be output in each of the first, second, and third rotational degrees of freedom and in the first translational degree of freedom.

55. An apparatus according to claim 51 further comprising a barrier between the handle and the gimbal mechanism.

56. An apparatus according to claim 51 further comprising a trocar between the handle and the gimbal mechanism.

Sub D1 14/5 (amended) An apparatus for interfacing a user with a computer providing a laparoscopic surgical simulation, the apparatus comprising:

a user object simulating at least a portion of a medical instrument used in a laparoscopic surgical procedure, said user object comprising a handle and an elongated member;

a gimbal mechanism receiving the user object and allowing the user object to be manipulated in first, second and third rotary degrees of freedom and in a first translational degree of freedom, the gimbal mechanism comprising a five member linkage;

C3 a sensing system coupled to the gimbal mechanism to detect manipulation of the user object in the first, second, and third rotational degrees of freedom and in the first translational degree of freedom, wherein said sensing system provides sensor input related to said manipulation in said first, second, and third rotational degrees of freedom and said first translation degree of freedom to said computer to control a virtual reality image in said laparoscopic surgical simulation displayed on a display device by said computer; and

an actuator coupled to the gimbal mechanism, wherein a capstan drum, cable and pulley transmit a force from said actuator to the user in one or more of the degrees of freedom, wherein the actuator outputs one or more forces associated with the simulation.

58. An apparatus according to claim 57 wherein the actuator is coupled to the gimbal mechanism through the cable and pulley to provide a force to the user in the first translational degree of freedom.

CH Sub D1 16/5 14/5 (amended) An apparatus according to claim 57 wherein said five member linkage is a closed-loop linkage and provides the first and second rotary degrees of freedom of the gimbal mechanism. C

60. An apparatus according to claim 59 wherein the actuator is coupled to the five member linkage through the cable and pulley to provide a force to the user in the first or second rotary degrees of freedom.

61. An apparatus according to claim 60 further comprising a second actuator coupled to the five member linkage through another cable and pulley to provide a force to the user in the first or second rotary degrees of freedom.

C5 Sub 14 62. (amended) An apparatus according to claim 57 wherein the cable transmits a force from the pulley to the capstan drum, the capstan drum being rigidly coupled to a linkage of the gimbal.

63. A system for training persons to perform a surgical procedure using a surgical instrument that is inserted and manipulated through a small incision in a patient, said system comprising:

- a housing with an opening;
- an implement for simulating said surgical instrument that is situated in said opening in said housing and manipulated axially and rotationally relative to said housing;
- a movement guide and sensor assembly for monitoring the position of said implement relative to said housing, said movement guide and sensor assembly having:
  - a) a cable;
  - b) a guide rail proximate to said cable;
  - c) a framed assembly for restricting the linear motion of said implement as it is moved relative to said housing to a predetermined axis;
  - d) a rotation sensor affixed to said implement for monitoring the axial rotation of said implement relative to said housing;
  - e) a position sensor for monitoring the axial position of said framed assembly; and
  - f) a servo motor applying a torque to said cable, which imparts a resistive force to linear motion of said implement;
- a display; and
- a processor for interpreting the data from said rotation sensor and said position sensor to determine the location and occurrence of force feedback to said implement, said force feedback created by said processor controlling said servo motor in response to said sensed applied force, said processor also controlling a visual simulation for said display.